

I – Problem Statement Title (04-EQ012)

Development of Accessible Hinge Details for Box Girder Bridges

II - Research Problem Statement

Question: How should in-span hinges in box girder bridges be designed and detailed to facilitate the inspection, repair, and replacement of elastomeric and PTFE bearings?

Replacement of in-span hinge bearings in box girder bridges for inaccessible hinges requires shoring of the superstructure and partial demolition of the existing hinge. This process can be very expensive and results in traffic disruptions. Inaccessible hinges are also difficult if not impossible to inspect. In order to reduce the costs and traffic impacts associated with bearing inspection and repair, it is necessary to make such bearings accessible through diaphragm openings. Consequences of constructing such openings near bearing locations need to be studied.

III – Objective

The main objective of the research is to quantify the change in stress flow in accessible hinge details developed by Caltrans through the use of analytical and physical scale models. Another objective is to develop an understanding of the behavior of such hinges under various load conditions, which would lead to better designs and easier construction. Use of regular reinforcement, headed rebar, and high strength rods will be explored as ways to relieve reinforcement congestion.

IV – Background

Current Caltrans design for hinges is based on ACI design requirements for corbels. Given the lack of test data characterizing the behavior of hinges designed under these requirements, the tendency of designers is to be very conservative when detailing such hinges, making the hinges difficult to build due to reinforcement congestion. As the size of the hinge seat increases due to increased span lengths and seismic movements, corbel design requirements may no longer be applicable. The introduction of access openings through the hinge diaphragms adds another level of complexity to the design and detailing of such hinges.

A Caltrans team is working on developing standard details for accessible hinges. The goal is to develop hinge details that allow for post earthquake inspection and/or repair of hinge bearings, while improving constructibility through better detailing and reduced reinforcement congestion. However, due to current inadequacies in the design process, the design team is relying heavily on engineering judgment to accomplish the initial phase of this effort. Caltrans team, in collaboration with the research team, will use the gained knowledge to develop comprehensive design guidelines and improve the standard details that were developed in the initial phase.

V – Statement of Urgency and Benefits

A. Support of the Department's Mission/Goals:

(Improving Mobility: Safety, Reliability and Productivity) Post-earthquake replacement of hinge bearings in inaccessible in-span hinges will lead to delays in reopening the bridge to traffic due to the fact that the operation requires partial demolition and reconstruction of the hinge. Bearing replacement in hinges with access openings would not require the bridge to be closed to traffic. The elimination of the demolition and reconstruction operations reduces the cost of bearing replacement greatly, allowing for more efficient use of highway dollars.

B. Return on Investment:

In previous bearing replacement operations, structure maintenance personnel estimated that the partial demolition and reconstruction of a single hinge adds about \$100,000 to the cost of bearing replacement. Bearing replacement construction activities can significantly affect traffic on or below the structure. This cost, and the impacts to traffic, would be eliminated if the hinge were designed with access openings. Improving constructability through the development of better details with reduced reinforcement congestion will have a significant impact on the cost of construction of such hinges. Costs associated with the economic impacts of extended post-earthquake bridge closure are difficult to estimate but could be in the millions.

VI – Related Research

A search was conducted on TRIS online (<http://ntl.bts.gov/tris>) and nothing on this subject was found. Another search was conducted on the Research In Progress database (<http://rip.trb.org/search>) and no records were found.

VII – Deployment Potential

As a result of this research, new guidelines and standard details for accessible hinges will be developed. These guidelines and details will simplify the design and improve the constructibility and maintenance of in-span hinges.